

NATIONAL ROCKETRY CHAMPIONSHIP

Manufacturing Review

Team Ursa

Luke Franklin, Hires Rughwani, Charikleia Kokkini, Sanjana Chowdhury, Veselin Velchev,
Harold Henrique Nery, Louise Paterson, Avish Sood, Sancho Mir, Abdullah Shaikh



Introduction

Team Ursa from QMUL

- Mission Statement
 - Team Ursa aims to complete a successful launch and recovery of a rocket that provides relevant data for analysis.
- Objectives
 - Design a custom PCB and rideshare payload
 - Reach target apogee of 2200ft
 - Safely recover launch vehicle.
 - Recovery of flight data for presentation to competition judges



Updates to Project:

A combination of factors have held back Team URSA from formally starting manufacturing.

- Queen Mary SU approval for suppliers. Some components now ordered out of pocket for Rideshare Payload.
- QMUL Makerspace Workshop approval for use of chosen epoxies & resins.
- Delayed response times from Lead Technician on student approval for workshop use. (Should have been addressed earlier)



[illegible]

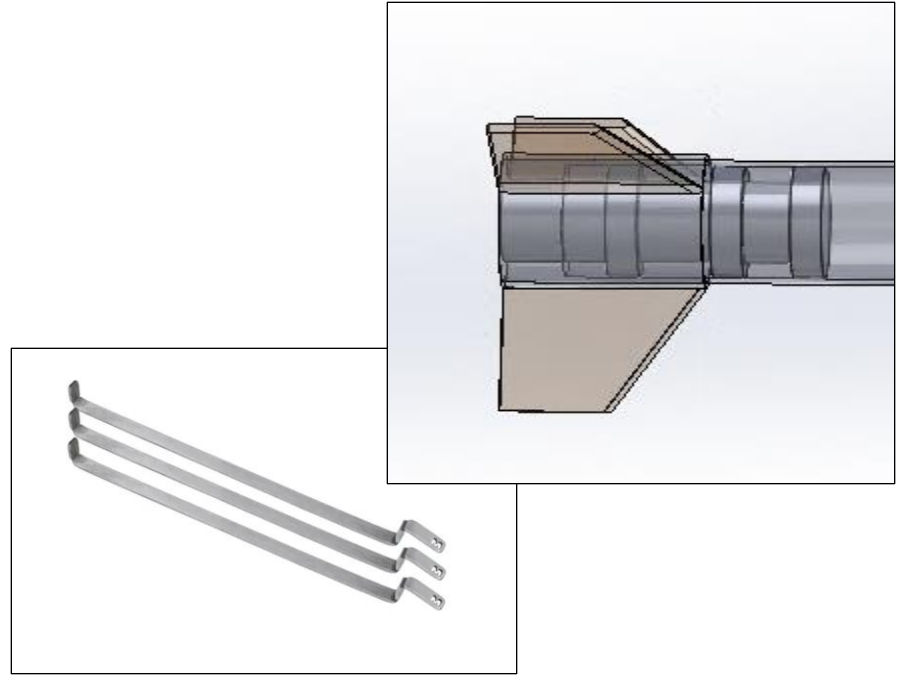
Updates to Project Budget:

	Area(s) / Item(s)	Estimated Cost (£)	Spent (£)	Allocated Budget (£)
Components / Materials	Airframe / Structure	80	-	100
	Propulsion	30	30	30
	Recovery	12	-	20
	Avionics	96	64.16	100
Manufacturing	Tools / Facilities	0 - 50	-	~20
BMFA Insurance	2x	98	-	98
	Totals:	316 - 366	94.16	~358



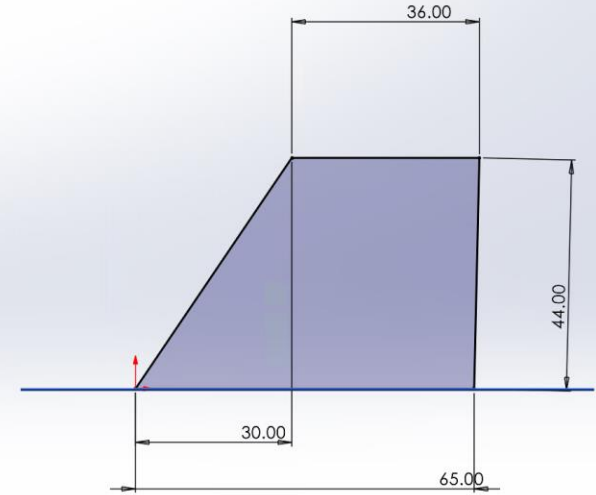
Launch Vehicle Manufacture Update: Motor

- Aerotech G74 motor attached to a 29mm motor mount.
- Yet to order motor clamps and manufacture thrust rings.
- Will be secured with a COTS motor mount approved for chosen class.



Fin configuration and Manufacture

- The internal fin can will be made from card and will sit just inside the lower fuselage .
- Will initially insert the can into the lower fuselage to check fit then secure with either epoxy or screws.
- 3 fin slots are cut into the lower fuselage equally spaced to the dimensions of the root of the fins .
- The 3 fins are cut from balsa wood and secured in a slot using epoxy.
- Correct alignment is ensured through use of dry fitting.

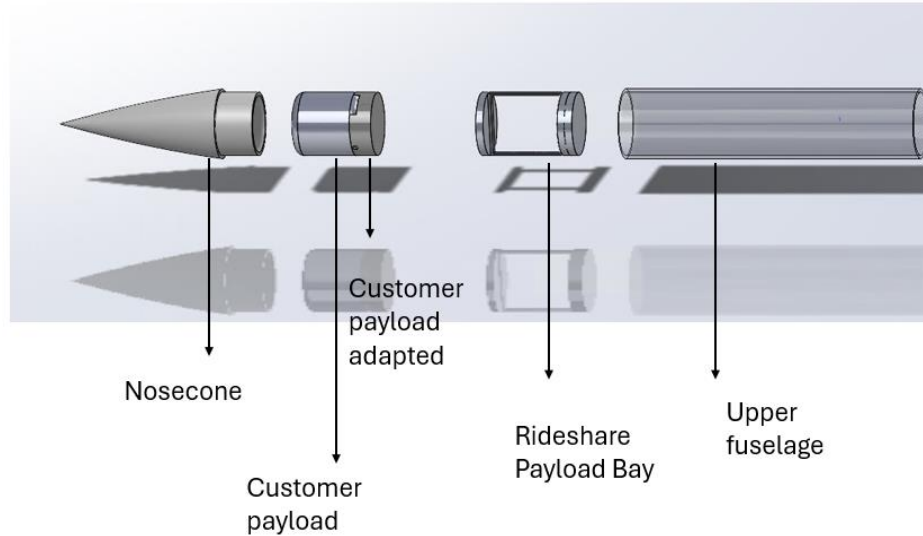


Airframe Manufacturing

- A layer of resin will add to the nosecone, body tube and fins to improve strength and stiffness:
 - Lightly sanding and cleaning surface to ensure adhesion
 - Apply a thin layer of epoxy resin evenly around
 - Smooth and leave to cure
- Insert the bulkheads
 - Lower bulkhead is inserted into the lower fuselage where it is attached above the motor bay with a vent for ejection gases
 - Another two bulkheads are placed in the recovery and payload section with an epoxy fillet keeping them in place.
- Glue in coupler
- Attach rail buttons
 - Ensure correct alignment



Payload Bay 3D Printing



Slicing for 3D print:

Use slicing software(Cura):

- Material: PETG filament
- Supports: as needed for overhangs

3D printing:

- Printer: Ender 3D printer with hardened steel nozzle
- Print orientation: Vertical for cylindrical parts to avoid horizontal layer delamination
- Post process:
 - Remove supports
 - Light sanding
 - Verify geometry



Payload Bay testing

Dimension inspection:

Use calipers to check:

- Outer diameter of Payload bay matches fuselage internal diameter
- Inner diameter of adapter matches payload outer diameter
- Tolerance ± 0.2 mm

Dry fit test

- Insert adapter into payload bay and bay into fuselage
- Ensure snug but non – forced fit
- Check alignment of features such as slots and fasteners as well as overall geometry

Mechanical fit test:

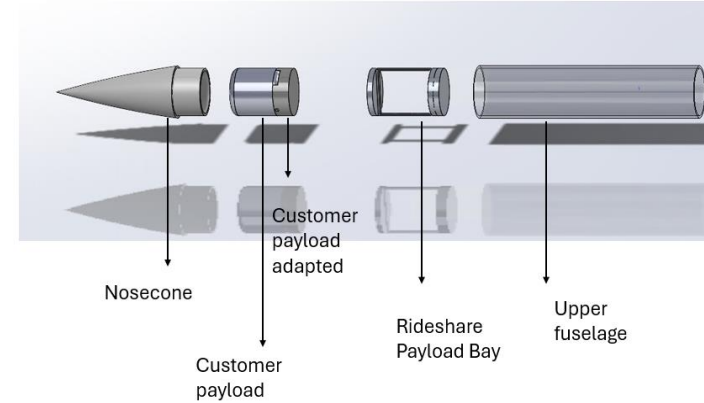
- Load dummy payload (same mass and shape)
- Shake test – simulate launch vibration by shaking horizontally and vertically
- Verify that the payload stays secure under forces

Insertion/removal ergonomics

- Test how easily the cartridge slides in and out

Structural test:

- Drop test – drop from waist height onto soft surfaces and check for cracks/ deformation
- Compression test – press down on payload adapter inside bay to simulate axial force



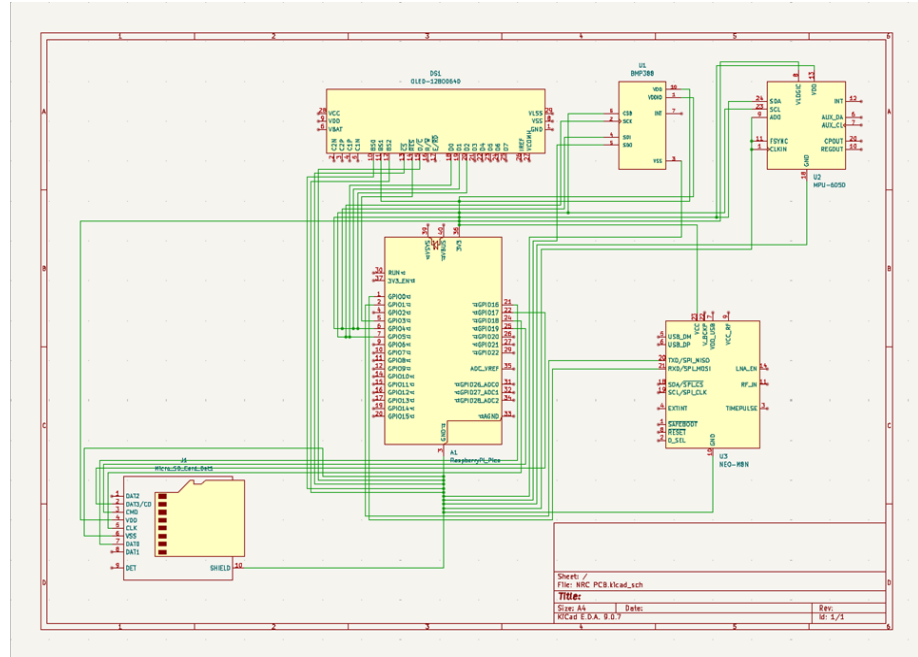
Airframe Testing

- General structural tests:
 - Stiffness – Suspend the rocket from Centre of Mass (COM) and measure deflection to test the resistance to the bending caused by gravity and forces during flight.
 - Bulkhead strength – Apply a distributed load to each bulkhead to emulate ejection pressure.
- Testing of the fins:
 - Axial loading – Use a force gauge and weights to test if the fins can withstand axial forces caused by pressure and vibrations during flight
 - Transverse loading – Suspend a weight equal to the rocket's mass at the wing tip and measure deflection to ensure that the fin does not break under side wind



Rideshare Payload

- **PCB Assembly:**
 - The custom PCB is fabricated using FR4 substrates
 - Components include the Raspberry Pi Pico 2, BMP388 Pressure Sensor and a MPU6050 6-DOF IMU.
 - Current design from KiCad
- **Payload housing and integration:**
 - Once tested PCB is mounted within payload bay using mechanical fasteners
 - Screw switches added to allow safe arming and disarming
 - Powered by : 3.7V 500mAh LiPo battery connected via JST-PH 2.0 to the Pico VSYS pin
- **Issue**
 - Currently waiting on the Custom PCB and Microcontroller to begin manufacturing.



Rideshare Payload testing

- Component testing
 - Once components are received, they will be assembled onto a bread board
 - Breadboard will each be tested to check they display the desired information.
- Testing PCB:
 - Once PCB is received components will begin to be soldered on
 - Soldering is visually inspected for cold joints or bridging
 - The completed board is then powered and tested prior to integration



Recovery Testing

Separation Test

- A tensile load is applied between the upper and lower fuselage sections
- Load approximates the force generated by the motor ejection charge
- The force needed to separate sections is recorded

Pass Criteria: Rocket separates under expected ejection force, No structural damage to airframe or recovery components

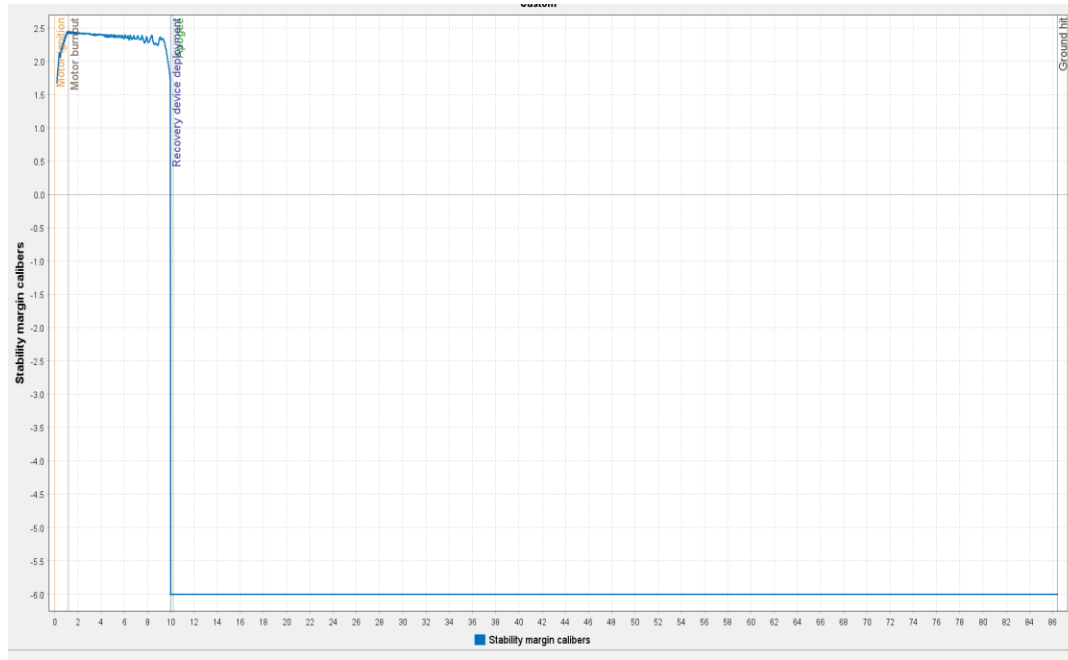
Parachute Deployment Test

- Recovery system is fully packed inside the airframe
- Manual separation of fuselage section is performed
- Parachute deployment behavior is observed

Pass Criteria: Parachute deploys smoothly without obstruction, No tangling of shock cord or canopy, full extraction achieved reliably.



Simulation data

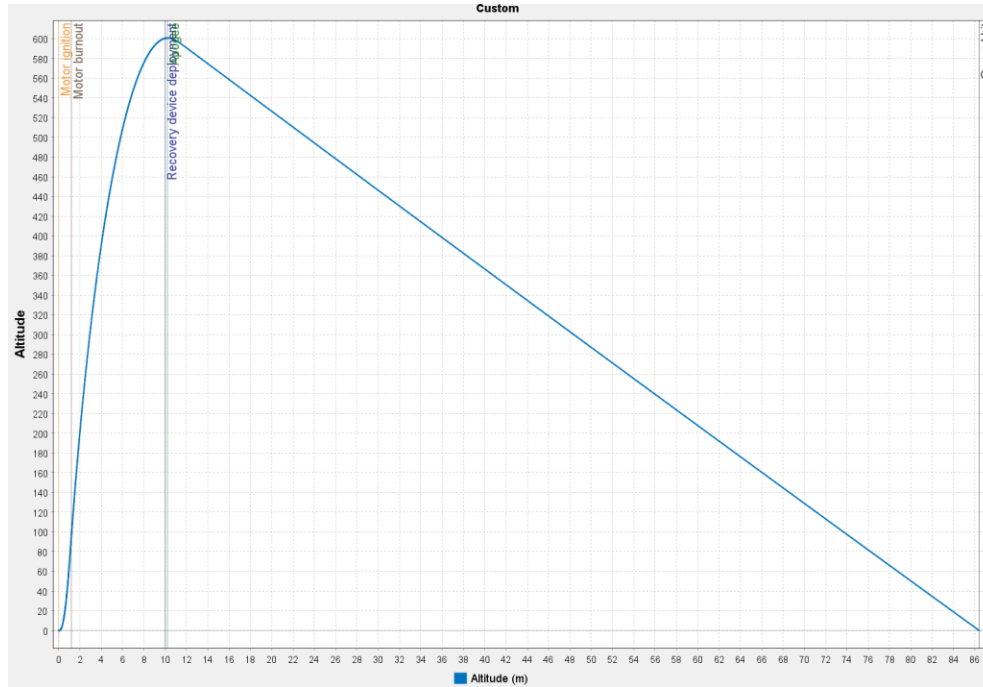


Changes to Fuselage Dimension:

- Width from: 44mm -> 50mm
- Length from: 550 mm -> 590mm

Stability margin now stays within 1.75 – 2.5 calibers for the entire flight (incl. Launch).

Simulation data



Predicted Apogee has
now dropped from:

662m - > 601 m
(~2171 feet to ~1971 feet)

System Engineering Update

The following is a list of requirements that are yet to be confirmed to be fulfilled because they would require testing of the rocket, which has not yet been manufactured:

Requirement	Requirement Title	Explanation
RS-TSN-MOR-001	Mounting of the motor	Provide a means of securely mounting the motor within the rocket
RS-TSN-MOR-002	Motor mount strength	The motor mount must withstand the force equivalent to twice the maximum motor thrust without permanent deformation
RS-TSN-MOR-003	Motor mount strength	The motor mount must be able to withstand a lateral force in any direction equal to a thrust misalignment of 5 degrees at maximum motor thrust cantilevered about the centre of gravity.
RS-TSN-SAR-002	Fin Longitudinal	Each fin must be able to support a suspended load from its tip equal to twice the fin mass times the rocket's maximum axial acceleration during any flight phase



System Engineering Update

Requirement	Requirement Title	Main Text
RS-TSN-SAR-003	Fin Lateral	Each fin must be able to withstand a transverse load equal to the rocket's launch mass suspended from the fin tip with a maximum deflection of less than 10 degrees either direction
RS-TSN-SAR-006	Static Strength	All structural parts shall withstand twice the expected maximum inertial and aerodynamic loads without failure
RS-TSN-ESS-002	Internal Power	The rocket must be able to be fully armed within 5 minutes at the launch site
RS-TSN-RRS-002	Landing speed	The recovery system must reduce the rocket's vertical landing speed to less than 15 m/s
RS-MRD-MIS-008	Mission	The launch vehicle should drift a maximum of 750m from the launch site under a windspeed of 10m/s during descent

Manufacturing and Testing Risk Management

Risk	Severity (/5)	Likelihood (/5)	Mitigation	Contingency
Injury from machining	5	3	Ensure proper use of machines and equipment as well as ensure proper training is completed as well as completing a brief beforehand do everyone understands risks	Make sure a first aider is present in case something goes wrong
Electrical hazard	4	2	Make sure proper care is taken in handling and dealing with electrical components	Make sure a first aider is present in case something goes wrong
Damaging components	1	2	Make sure care is taken when handling components and manufacturing to not damage parts	Parts can be reordered if damage cannot be repaired
Testing causing damage	2	2	Make sure tests done are non-destructive to avoid damage being made	Repairs can be made if needed



Next steps and Future improvements

- When parts are confirmed to have been delivered manufacturing will begin
 - As semester is ending more time will be available to ensure manufacturing and testing are completed before flight readiness review.
- Only planned adjustment to design is a change in Airframe Diameter



Thank you

